

In the orderly condensation of swarms, according to the meteoritic hypothesis, the earlier stages are—

Ascending temperature.	Cygnian .....	Dark lines, corresponding chiefly with the enhanced lines of various metals.
	Polarian .....	Dark lines, comprising both arc and enhanced lines of various metals.
	Aldebarian .....	Dark lines, chiefly corresponding to those which appear in the arc spectra of various metals.
	Antarian .....	Mixed bright and dark flutings and dark lines. Bright hydrogen lines in those stars which are variable.
	Nebula .....	Bright lines.

In the case of new stars, after the maximum of luminosity has been reached, however high they ascend, short of the apex of the temperature curve, this order must be reversed, and hence we should expect to find the spectrum varying in accordance with the foregoing sequence, but in the reverse order.

In Nova Coronæ (1866), according to the observations of Sir William Huggins and Dr. Miller, the absorption spectrum was very similar to that of  $\alpha$  Orionis, which is a star of the Antarian group, so that the temperature attained was relatively low; this, indeed, is demonstrated by the fact that at present it shines faintly as an Antarian star, and doubtless did so before the collision. The collision, therefore, probably did not take Nova Coronæ very much above its initial stage of temperature, and when the disturbance was over it simply reverted to its old conditions.

The spectrum of Nova Cygni (1876) was not photographed, and as special attention was given by most observers to the bright lines, there is no satisfactory record of the absorption spectrum.

This now appears as a nebula, and doubtless it was a nebula to begin with, as Nova Coronæ was a star to begin with.

In Nova Aurigæ (1892), as we have seen, the comparison with a Cygni indicates that the Cygnian (that is, a higher) stage was reached, and in the final stages its spectrum corresponded with that of the planetary nebulae, that is, a stage lower than that reached by Nova Coronæ. The intermediate stages, however, were not observed, possibly because the star was never very brilliant, and partly because of the difficulty of observing closely grouped lines, such as occur in the Polarian and Aldebarian stages when they are rendered broad by such disturbances as those which were obviously present in the Nova.

The observed maximum magnitude in the case of a new star will evidently depend upon the distance and size of the colliding masses, as well as upon the temperature produced by the collision. It is not remarkable, therefore, that there is no apparent relation between the greatest brightness and the temperature indicated by the spectra. Nova Coronæ, with its relatively low temperature, shone for a time as a second magnitude star, while Nova Aurigæ, with a much higher temperature, scarcely surpassed a star of the fifth magnitude.

I now return to Nova Persei.

If the idea that in the present Nova the swarm which gives the dark line spectrum resembles a Cygni be confirmed, as its temperature is reduced we may expect it to pass successively through some or all of the stages of temperature represented by stars of the Polarian, Aldebarian and Antarian groups, enhanced lines being first replaced by arc lines and then by flutings. Whether it remains at one of these stages or undergoes a further backwardation into a nebula will be a point of the highest interest.

If, like Nova Aurigæ, the present Nova should end as a nebula, it will furnish a most convincing proof of the fundamental metallic nature of nebulae.

In conclusion, I wish to express my thanks to Dr. W. J. S. Lockyer and Mr. F. E. Baxandall, of the Solar Physics Observatory, and to Mr. A. Fowler, of the Royal College of Science, who have greatly assisted me in preparing the present note, and who, with the addition of Mr. Butler, of the Solar Physics Observatory, secured the excellent set of photographs and eye observations on the night of the 25th, from which the new knowledge has been derived.

The preparation of the slides I owe to Mr. J. P. Wilkie.

Solar Physics Observatory, February 28.

### RECENT SWISS GEOLOGY.

THE glaciers of the Alps have lost considerably in bulk during the last forty years. This began at rather different dates, for some were still advancing in 1860, while by 1870 the diminution was very marked. Since then there have been slight oscillations, but until lately loss, on the whole, has exceeded gain; now, perhaps, the tide has turned. The report on the Unter Grindelwald glacier, by Prof. A. Baltzer,<sup>1</sup> describes the changes this glacier has undergone during the above-named period, and the results of some special observations made between 1892 and 1897. It was unusually well suited for the purpose, for its changes had been very conspicuous, and they had been already more closely observed than in many other glaciers.

In 1858, as is shown in a photograph, the glacier descended to the level of the valley beneath Grindelwald, where the Weisse Lütschine, in the summer of that year, issued from an ice cave. By 1870 the glacier had retreated up the glen between the Eiger and the Mettenberg, exposing three great rocky steps, the existence of which, it may be remarked, is anything but a favourable testimony to the excavatory power of ice; and its thickness higher up had so much diminished that the writer looked down a cliff, fully sixty feet high, on to the surface very nearly at the place where he remembered stepping easily from the ice to the rock on his way from the Strahleck Pass. A photograph representing the state of the glacier in 1895, on which Prof. Baltzer has indicated its former extent, shows how great the change has been; the modern ice stream looking, by comparison, like a caterpillar crawling to hide its diminished head in a rocky gorge (Fig. 1). One remarkable effect of this shrinkage (as described by Mr. F. F. Tuckett in the *Alpine Journal*, vol. vi. p. 30), was to lay bare, in 1871, a quarry in a bed of mottled pale red and green marble, which had once been extensively worked, but for about a century had been completely hidden beneath the ice. By the retreat of the glacier large areas of ice-worn rock have been exposed, several of which are represented by photographs in Prof. Baltzer's memoir. From study of these he concludes that there are two forms of ice-erosion; one—the ordinary—smoothing or abrading of the rock surfaces; the other, a tearing and a splitting off of fragments in cases where the rock is much traversed by divisional planes. As he deems this to have been less generally recognised, he illustrates it by photographs. It is difficult without actual examination of the localities to form an opinion on this point. That the rock, chiefly from mechanical causes, is readily broken is beyond question; but, though the fragments thus formed would be more easily removed than from a solid mass, it is doubtful whether the ice plays more than a secondary part, so that the remark would be equally true of any other kind of erosion. Given an irregular surface, the friction of a body moving over it would tell upon the prominences; but probably more pieces fall away than are broken away.

<sup>1</sup> Vol. xxxiii., part 2, of the *Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft*.

The more minute observations on the changes in the volume of the glacier, which have been carried on from 1892 to 1897, prove constant variation, and suggest a connection with the prevalent temperatures. It is to be hoped these will be continued, for they will aid in the discovery of the causes to which the greater changes are due. The past history of the glacier shows a marked period of advance to have begun about the year 1600, reaching a maximum in 1620, after which it retreated. A strong advance set in at the beginning of the eighteenth century, and it attained a maximum just a hundred years after the former one, the ice then retiring. About 1743 it again advanced, but only for a short time, and this was followed by a marked retreat. But from 1770 to 1779 there was a great advance (which probably buried the marble quarry, and, so far as is known, hid it for nearly a century). But since then the oscillations have been considerable, for two periods of advance are recorded, one from 1814 to 1822, the other from 1840 to 1855, the effect of the latter remaining, as has been said, for four or five years. It is at present difficult to explain these singular changes of volume in the glaciers; very probably they are connected with both

bilities of nature, upon the imago of lepidoptera, the pupa of which have been thus treated. The cold, speaking generally, seems to reduce the size of the imago and makes it paler in colour, the heat having the contrary effect. The second memoir, "Monographie des Genus *Elaphoglossum*," by Dr. H. Christ, illustrated by four plates, is an elaborate botanical study.

Vol. xxxvi. (1900), Part ii. also contains two memoirs. One is by Prof. Ed. Fischer, "Untersuchungen zur vergleichenden Entwicklungsgeschichte und Systematik der Phalloideen," illustrated by six plates and four cuts in the text, in which the relationships of the several forms are elaborately worked out. The other, by Dr. Emil Hugl, "Die Klippenregion von Giswyl," with six plates of sections and scenery, gives a full and careful description of one of these remarkable isolated rock masses, which are so frequent on the northern margin of the Alps and Carpathians. Sections representing the actual stratigraphy of the district are followed by others showing how this has been produced; namely, by an overfolding followed by denudation, more especially affecting one of its limbs, and that by a second folding in this portion which has resulted in an overthrust.

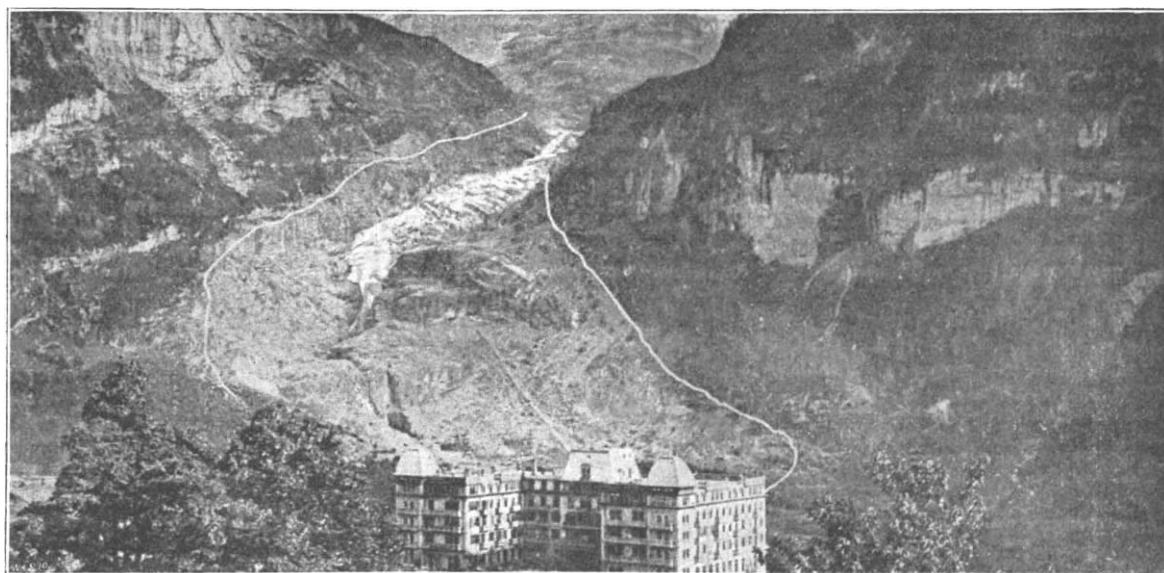


FIG. 1.—The Unter Grindelwald Glacier in 1895. The white lines show the extent of the glacier in 1858.

winter snowfall and summer temperature, but the former, as chiefly affecting the upper part of a glacier, may be some years before it produces an effect at the lower end, while that will be more immediately sensitive to summer warmth. Hence each glacier must be separately studied, as this one has been by Prof. Baltzer. The importance of the investigation is now generally recognised, and that not only in the Swiss Alps. In these, according to Dr. Richter (*Archiv. Genev.* vi. 1898, p. 22), of fifty-seven glaciers observed in 1897, fifty were still decreasing, five were stationary, and twelve were increasing, so that it will evidently be difficult to fix very precisely a date for the maximum and minimum of a whole region.

Other memoirs recently issued by the Swiss Society of Natural Science deal with various subjects. Vol. xxxvi. (1899), Part i. contains two memoirs. One, by Dr. M. Standfuss, "Experimentelle Zoologische Studien mit Lepidopteren," illustrated by five plates, is an investigation of the effect of temperature, either continuously higher or lower than the average, but within the possi-

Dr. Zschokke's memoir on "Die Tierwelt der Hochgebirgsseen," vol. xxxvii. (1900), pp. 400, with three maps and eight plates, gives much information on the physiography of the lakes of the Higher Alps, as well as a full account of their fauna. Here we find local reproductions of almost Arctic conditions in the midst of a temperate zone, and the fauna, in many respects, may be representative of glacial times. During these the lakes would be mostly, if not wholly, occupied with ice, but as it gave place to water this would be peopled by organisms, partly transferred by birds, partly making their way up stream from lower levels. Of this fauna Dr. Zschokke gives lists and descriptions. It is far from inconsiderable, having representatives of the majority of the invertebrata from the rhizopods upwards, with fishes and amphibians as vertebrates. Of the former, thirteen species are mentioned as occurring in lakes over 1400 m. above sea-level, *Salmo lacustris* and *S. salvelinus* having the highest range, for they occur in the Finailsee, 2690 m. Of amphibians six are enumerated, of which *Rana fusca* reaches the greatest elevation, being found up to 2400 m.



Dr. Zschokke's memoir is full of most valuable information and will be for long consulted by all interested in the distribution of life in the Alps.

Dr. Lorenz's monograph<sup>1</sup> deals with a rather isolated range of no great elevation, the culminating point, the Fläscherspitz, being only 1137 m. above sea-level, but it is one of great interest, which has attracted the attention of Swiss geologists for quite half a century because of its palæontology (the strata range from the Inferior Oolite upwards) and its tectonic structure. On the former ground it is chiefly remarkable, because here the fauna of the "Dogger" changes from its western to its eastern facies; on the latter because its geological structure is extremely complicated, and the relation which it bears to the neighbouring parts of the chain is not easily determined. The range has a general trend from north-west to south-east, the smaller part being in the Principality of Liechtenstein and the rest in Canton Graubünden. A study of the tectonic structure shows the range to consist of Jurassic and Neocomian beds, its south-eastern portion being formed of a much-broken overfold pointing towards the north-west, followed in this direction by a synclinal, which includes a minor overfold and has its axial plane roughly parallel to the former one. Dr. Lorenz connects these crust wrinklins with the famous "Glarner doppel-falte," which, however, he would prefer to call the "Glarner Bogen." The structure, in his opinion, is a result of the sinking (senkung) of the Oberland massif. He gives a succession of sections along the line of curve to prove the relationship, but we should substitute "upheaval" for "sinking" in explaining the structure. The crystalline core indicates the region where the oldest rocks have been raised to the greatest elevation, and have thus produced, by their resistance to further movement, the wrinkling, overfolding and overthrusting of the peripheral sedimentary masses. He thinks also that there have been two sets of movements, which indeed is corroborated by other regions of the Alps.

#### GEORGE FRANCIS FITZGERALD.

THOSE who knew the University of Dublin twenty years ago will remember that the idol of the undergraduates and the hope of the older men was George Francis FitzGerald. He was of high intellectual lineage on both sides: his father was the most distinguished prelate in the Irish Protestant Church, and his uncles are men of large and original scientific achievement. His early education was conducted at home, in company with his two brothers, one (now professor of engineering at Belfast) a year older than himself, the other younger. He was good at physical science and all subjects requiring close observation, from his earliest years; and the ambition to become a master was soon aroused. The mathematical and physical tendency seems to have come mainly from his mother's side, his strong metaphysical bent from both sides of the family. In his student career he attained all the distinctions that lay in his path with an ease, and wore them with a grace, that endeared him to his rivals and contemporaries. On taking his first degree in 1871 he settled down, at twenty years of age, after the manner of the pick of the Dublin men, to a wide and independent course of reading with a view to a Fellowship. At that time vacancies were of very rare occurrence; so that it was not until 1877, on his second time of trying, that he attained the position of a Fellow of Trinity College. The examination in mathematical and physical science included papers on selected portions of the works of the great mathematical

physicists; to a mind of the calibre of FitzGerald's, the early and intimate acquaintance which was thus promoted with the classical writings of Lagrange and Laplace, of Hamilton and MacCullagh, with their modes of thought as well as the results that they won, must have formed the best possible foundation for a scientific career. A training which aims only at sound knowledge and established results may find a shorter path in the study of the latest text-books of the day; but if a man is to be a true leader he must be interested even more in the philosophy than in the facts of his science. It must have been of rare value to a maturing mind of keen temper to observe closely at first hand the lines of attack of the great masters of the past age on problems which were crystallising into knowledge. Acquaintance with the present state of science, however detailed and exact, assumes its full value as an instrument of progress only when it is accompanied by appreciation of the difficulties that had to be circumvented in order to reach it, and by observation of the way in which complete logical precision may have to be attained at the expense of temporary limitation. The subjects that were grouped around physical optics were approached in Dublin, in those days, through the study of MacCullagh's optical memoirs; these writings were based on a remarkable combination of keen analysis of the facts and direct application of the generalised dynamical methods of Lagrange, thus presenting all that interest of nascent scientific discovery which the same topics still retain in their wider connection with the general problem of the æther. Whatever may be the defects of MacCullagh's analysis, it had the saving merit that it put forward no claim to finality; its critical comparison and contrast with those of Cauchy and Neumann and Green, and the difficulties which its procedure suggested from a restricted dynamical point of view, were the very things with which a mathematical analyst might be impatient, but over which a mind constituted like FitzGerald's would eagerly brood. When the great Treatise of Maxwell, which threw a flood of light on these fundamental problems from an altogether novel source, came into hands thus prepared for its appreciation, it is not surprising that a main scientific interest became established for life.

After obtaining his Fellowship, FitzGerald became attached to the department of experimental physics, and conducted or influenced much of the teaching in physical science, in addition to carrying on the work of a College tutor. In the latter capacity he was eminently successful. It was an object of ambition to gain admission to his side, which was always full a long time in advance. He had considerable athletic prowess, which was kept up for many years; and his services were in great request for presiding over and administering the athletic organisations of the College. He gave up tutorial work in 1881 on succeeding to the chair of experimental philosophy, which he held for the rest of his life. He became a Fellow of the Royal Society in 1883, and in 1899 received the award of one of its Royal Medals.

In those early years there were three main centres of development of the new departure in electrical theory which has since revolutionised the whole domain of physical science. Maxwell's own presence as a professor had guided the trend of physical thought at Cambridge predominantly into that direction which it has since largely retained; in Berlin, Helmholtz was devoting his great powers and turning the attention of his pupils to the discussion and elucidation of the subject; while in Dublin its study and investigation became vital under FitzGerald's lead and influence. His chief formal memoir, "On the Electromagnetic Theory of the Reflexion and Refraction of Light," was presented to the Royal Society at the end of the year 1878; it retains a place among the classical writings of modern physics. In the years from 1880 to 1885 he contributed to the

<sup>2</sup> "Monographie der Fläscherspitz." By Dr. Th. Lorenz. Beiträge zur Geologischen Karte der Schweiz, Neue Folge, X. Lieferung, with geological map, 4 plates of sections, and 13 other illustrations. Pp. 64.